R01AN6521EJ0100
Rev.1.00

RH850/U2B Group

Temperature Sensor (OTS) Application Note

Summary

This application note explains about the temperature sensor (OTS) function in the single chip microcomputer RHH850/U2B for the automobile by RENESAS Electronics.

Aim of this document and software is to provide supplemental information for the function on RH850/U2B. It is not intended to implement in the design for mass production.

There is no guarantee to update in this document and software to reflect the latest manual, errata, technical update and development environment. You are fully responsible for the incorporation or any other use of the information of this document in the design of your product or system, and please refer to latest manual, errata, technical update and development environment.

Target Device

RH850/U2B Group

Target Integrated Development Environment

CS+ (from RENESAS Electronics)

Device File : DR7F702Z21*.DVF
DR7F702Z22*.DVF

Reference Document

RH850/U2B User's Manual : Hardware

For function details and electrical characteristics, please refer to "User's Manual: Hardware".

This application note is based on the following manual.

- RH850/U2B User's Manual (Rev.1.00): R01UH0923EJ0100

Items

1. Introduction

This application note describes the usage for the power supply voltage monitor and the software making example of RH850/U2Bx.

1.1 Use Function

The following shows the RH850/U2B hardware function using in this allocation note.

- Temperature Sensor
- OS Timer (OSTM)

1.2 Function Overview for Temperature Sensor

The following shows the specification of the temperature sensor.

- Temperature data register
  - Store the temperature measured value.
- Temperature Measurement Mode
  - One-time measurement mode
  - Continuous measurement mode
- Support temperature measurement end interrupt
- Support abnormal temperature error and temperature rising/falling interrupt
- Self-diagnosis function
- Error reduction by temperature collection
  - Temperature collection coefficient is stored to the coefficient registers A to C.

2. Temperature Sensor Operation Example

2.1 Specification Overview

Explain the usage of temperature sensor.

The temperature sensor prepares one-time temperature measurement mode and continuous temperature mode and continuous temperature measurement mode as the measurement modes.

Table 2-1 shows the measurement start/end trigger.

Table 2-1 Measurement start/end Trigger

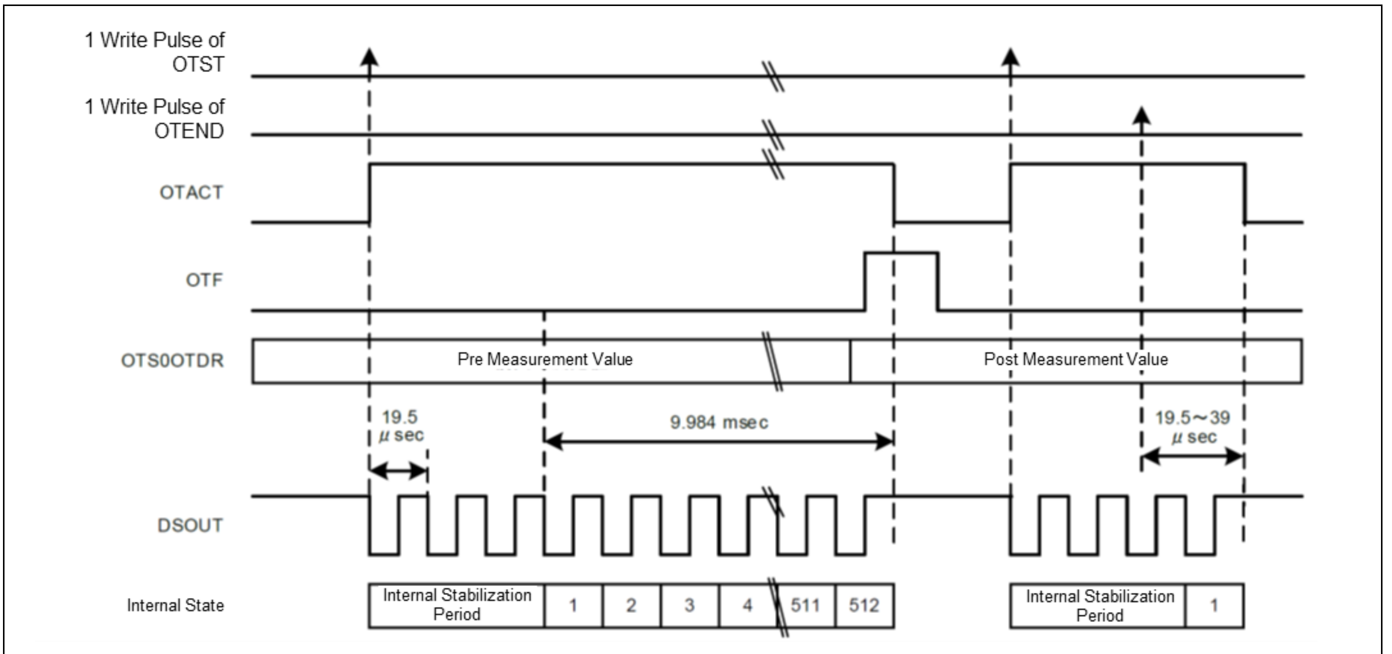
Measurement Mode	Measurement Start Trigger	Measurement End Trigger
One-time measurement mode	1_B writing of OTS0OTSTCR.OTST	1) End automatically after measuring one-time temperature measurement. 2) 1_B writing of OTS0OTENDCR.OTEND
Continuous measurement mode	1_B writing of OTS0OTSTCR.OTST	1_B writing of OTS0OTENDCR.OTEND

2.1.1 One-time Measurement Mode

Figure 2-1 shows the temperature measurement operation of the one-time measurement mode. The one-time temperature mode updates the temperature result by 515 states including the measurement preparing period, and ends the temperature measuring operation.

The outputting time by converting the temperature data to digital code requires 512 stats (9.984ms) when OTS clock is stated once.

After immediately starting measurement using the OTS0OTSTCR.OTST bit, 3 states are required as a measurement stabilization period.

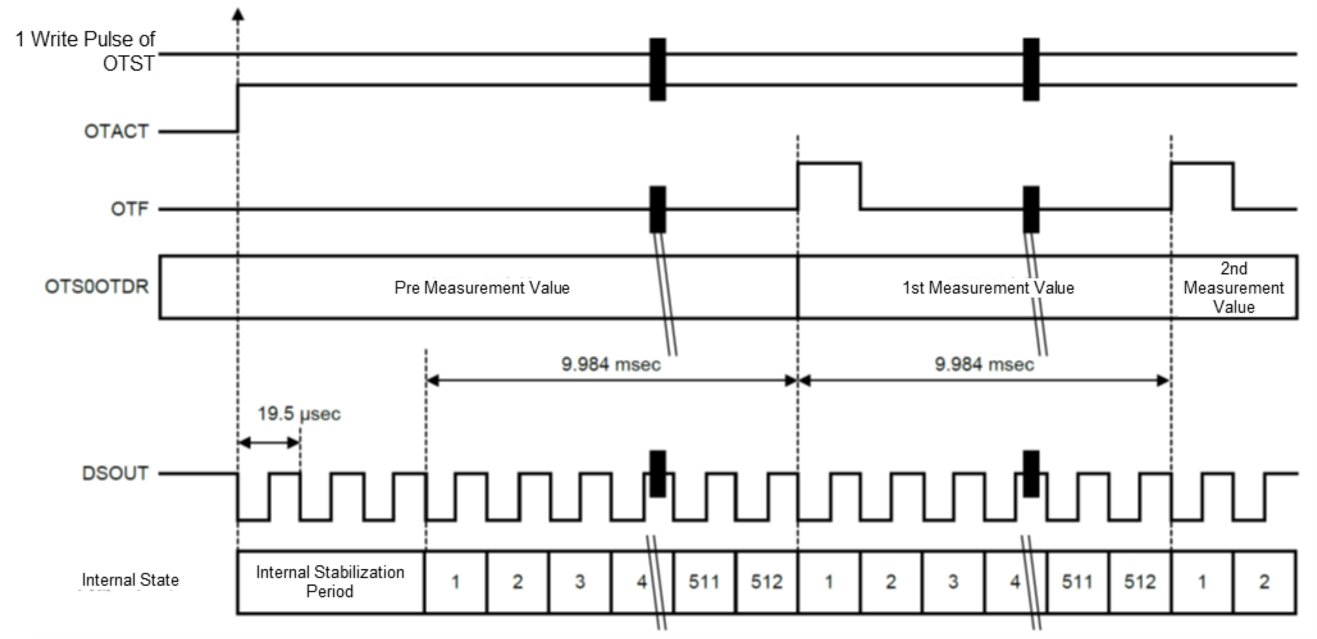


DSOUT is the operation clock of the temperature sensor that is obtained by dividing CLKC_LSB.
DSOUT period is 19.5 µs (when CLKC_LSB is 40 MHz).

Figure 2-1 One-time Measurement Mode

2.1.2 Continuous Measurement Mode

Figure 2-2 shows the temperature measurement operation in continuous measurement mode. In continuous measurement mode, the temperature measurement results are updated every 515 states, including the 3-state measurement preparation time for the first temperature measurement, and every 512 states from the second temperature measurement onwards. Also, the continuous measurement operation is repeated until “1” is written to OTENDCR.OTEND.



DSOUT is the operation clock of the temperature sensor that is obtained by dividing CLKC_LSB.
DSOUT period is 19.5 μs (when CLKC_LSB is 40 MHz).

Figure 2-2 Continuous Measurement Mode

2.2 Use Function

The hardware functions used in this operation example are shown below.

- Temperature Sensor
- OS Timer (OSTM)

2.3 Explanation of Operation Example

In this operation example, the measurement mode of the temperature sensor is set to the continuous measurement mode. Issue INTOSTM0TINT interrupt every second to use OS timer (OSTM). Store the measurement temperature to the variable in INTOSTM0TINT interrupt processing.

2.4 Software Explanation

2.4.1 Module Explanation

The following shows the module list in this operation example.

Table 2-2 Module List

Module Name	Label Name	Function
Main routine	ots_main	Perform various setting and application startup.
Interrupt initialization routine	intc_init	Perform initial setting of interrupt function.
Temperature sensor initialization routine	ots_init	Perform initial setting of temperature sensor.
OSTM initialization routine	ostm_init	Perform initial setting of OS timer.
Interrupt processing routine	ostm_int	Interrupt function. Store measured temperature to variable.

2.4.2 Register Setting

The following shows the register settings for each function in this operation example.

Table 2-3 Register Setting of Temperature Sensor

Register Name	Setting Value	Function
OTS0OTCR	0x01	Set temperature measurement mode to continuous measuring mode.
OTS0OTFCR	0x05	Temperature sensor flag clear
OTS0OTSTCR	0x01	Temperature measurement start

Table 2-4 Interrupt Register Setting

Register Name	Setting Value	Function
EIBD360	0x00000000	Bind INTOSTM0TINT to PE0 (CPU0).
EIC360	0x0040	Set INTOSTM0TINT interrupt as following. Interrupt reference method：Refer to table Interrupt priority：Level 0

Table 2-5 OSTM Register Setting

Register Name	Setting Value	Function
MSRKCPROT	0xA5A5A501	Enable write access to protected register.
	0xA5A5A500	Disable write access to protected register.
MSR_OSTM	0x000003FE	Set OSTM0 operation enable.
OSTM0CMP	0x04C4B3FF	Set start value of down counter. In this operation example, calculate the start value of the down counter as following for issuing INTOSTM0TINT interrupt every 1s. INTOSTM0TINT interrupt cycle/ count clock cycle - 1 =1s * 80MHz – 1 = 79,999,999 (0x04C4B3FF) count
OSTM0CTL	0x80	INTOSTM0TINT interrupt enable, set to interval mode.
OSTM0TS	0x01	Count start

2.4.3 Operation Flow

The following shows the flowchart in this operation example.

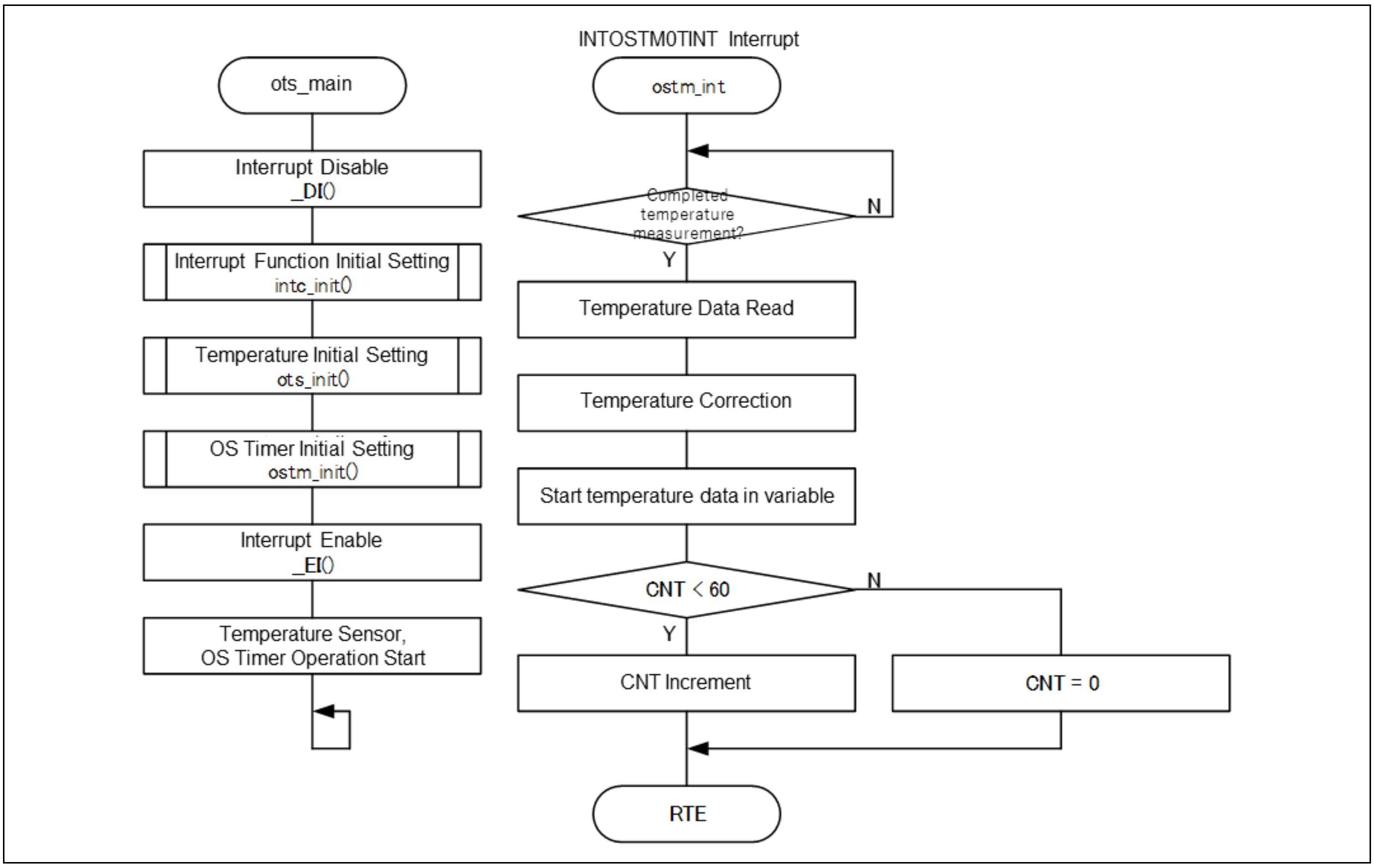


Figure 2-3 Flowchart

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2024.03.27	All	Initial issue.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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